undertaken to examine the records from these various outlying observatories before they are sent to the central office. Nor is it necessary to detail the other steps which have from time to time been taken by the Meteorological Committee to insure instrumental and observational accuracy; for men of science have only to examine the various publications of the office to be convinced that a large amount of accuracy has been already achieved.

In addition to the observations from self-registering instruments, other records of a less complete nature come to the office in continually-increasing quantity; for, evidently, the records from only seven stations, however completely equipped, are insufficient to give us a true view of the very complicated meteorology of these isles. It is, therefore, an important duty of the chief officer of the Committee so to increase this stock of observations as to obtain in time a complete and trustworthy meteorological record. There seems reason to believe that this will ultimately be done, and it will be a great boon to meteorological science when it is accomplished.

But, if the observational system is important, the method of reducing observations is a point of equal importance. The condensed account of the quarter's weather, and of its easterly storms, by Mr. Scott, are exceedingly useful summaries, and form, as it were, the first step of the ladder which leads from facts to laws, and it is hardly necessary to state that such summaries have a practical as well as a theoretical importance.

We pass on from these to consider next the tables of averages for the year 1869, which have been given in this Quarterly Report. As far as the air-temperature and pressure are concerned, there can be no objection to tables giving average results. These are two meteorological elements of a nature sufficiently simple to render averaging desirable; and the five-day means of those elements given in page 41 form, perhaps, the best way of accomplishing this. But surely the readings of the wet-bulb thermometer do not represent any simple meteorological element! The moisture is best represented by ascertaining the mass of vapour present in a cubic foot of air, this forming its legitimate expression in terms of *mass* and *volume*, which are fundamental physical conceptions. On the other hand, the temperature of the wet bulb, while it forms the easiest and best observational method of obtaining continuous information regarding moisture, is yet in reality a very complicated joint function of the temperature of the air, of its pressure, and of the mass of vapour present in one cubic foot. To give five-day readings of the wet-bulb thermometer cannot, therefore, we think, lead to any good result.

We are just beginning to know a little about the motions of the atmosphere and its variable components, and if we wish to extend our knowledge in this direction, it seems perfectly essential that the physical meteorologist should choose proper methods of reduction. His method ought not to be one which, when accomplished, *may possibly* increase our knowledge, but one which, from its very nature, *must necessarily* do so. He ought to seek to have the same certainty which the astronomer possesses, that in treating his observations after a particular method, the results will infallibly extend his knowledge of celestial motions.

We have dwelt so long upon this part of the labours of the Meteorological Committee, that we can only briefly allude to their system of publication. The reduced graphical representations of the observatory records given at the end of the volume, while hardly enough for the wants of meteorologists, are yet extremely valuable and useful. It is impossible to say what benefit to science may not result from bringing before the public such a speaking epitome of weather, and we owe many thanks to Mr. Francis Galton, the member of the Meteorological Committee who invented the instrument which has given us these admirable plates.

BALFOUR STEWART

BEET-ROOT SUGAR

On the Manufacture of Beet-Root Sugar in England and Ireland. By William Crookes, F.R.S., &c., Editor of the *Chemical News.* Illustrated with ten engravings. Pp. 290. (London: Longmans, 1870.)

THIS work is founded on a series of articles by M. Julien M. Deby, C.E., published about a year ago in the *Scientific American;* these articles have, however been very much extended, and much new matter added, in order to bring the subject down to the present date, and so increase its usefulness in assisting those who may wish to establish beet-root farms and sugar factories in this country. The experiences obtained abroad, and investigations made in England and Ireland, show that it would be quite possible to grow sugar-beets with profit in the United Kingdom. The beets might be used as fallow crop and cultivated, instead of the roots grown in such great quantities as food for cattle, since the beet-root pulp after the extraction of sugar is even more valuable for this purpose.

During the year 1867, beet-root sugar of the value of 1,600,000*l.* was imported into this country, and it would appear that this might readily have been produced here. In the first chapter we have a description of the beet, and of the qualities that can most profitably be used for sugar making; the weight of each root should not be less than 1¼lb., nor more than 2lbs.; smaller roots are frequently woody, while larger ones are watery and poor in sugar. The juice should have a specific gravity between 1·060 and 1·070, though sometimes, when very rich in sugar, it rises to 1·075 or 1·078. The percentage of sugar in the roots varies considerably, the minimum quantity given in a long list of analyses being 3·62, while the maximum is 13·47. The next number below this maximum is 13·19, and is interesting as representing the amount of sugar found in red beet manured with London sewage. Peligot obtained as much as 18 per cent. from some French beets, and some American specimens have produced 17·6 per cent. It has been found in Ireland that from 16 to 40 tons of roots may be grown on one acre, so that satisfactory results might be anticipated in that country. Chapter II. treats of the culture of the beet, the climate, kinds of soil, manure, and all the necessary directions to the agriculturist to ensure a profitable return. Chapters III. to VII. contain a detailed description of the mode of extraction of the sugar, and a very useful statement of the cost of the different pieces of apparatus required for working up 150,000lbs. of beet-root per twenty-four hours during five months, which

© 1870 Nature Publishing Group

would be the average yield of a 500 acre farm. Chapter VIII. gives the quantity of water required in such a factory, amounting to no less than 113,190lb., or 1,882 cubic feet per hour; the expense of labour for one year at 5,190*l.*, the total annual expense being 13,980*l.*, the total receipts being estimated at 20,470*l.*, leaving a profit of 6,490*l.*, assuming that 8 per cent. of sugar is extracted from the roots. It is however probable that this percentage might be raised to 10 per cent., when the profit would be 10,090*l.* The first outlay for the establishment of the factory is calculated at 10,845*l.* Mr. Baruchson estimates the profit at $24\frac{3}{4}$ per cent. on the outlay when $6\frac{1}{2}$ per cent. of sugar is produced, each additional $\frac{1}{2}$ per cent. increasing the profit $7\frac{1}{2}$ per cent., so that if 8 per cent. could be obtained the profit would be no less than 48 per cent. The ninth chapter describes the concreting process of Mr. Fryer as applied to the raw juice, so as to enable the refinery to be carried on during the whole year instead of only during crop time. Chapter X. is devoted to the application of the spent beet-root pulp. As far as chemical analysis indicates it will prove, when mixed with other materials, a more useful food for cattle than ordinary mangolds or even than the original roots, though it must be admitted that no comparative experiments on feeding have yet been made. The remaining five chapters describe the manufacture of spirit from beet juice, which has been found very profitable on the Continent; the sucrate of lime process which dispenses with the employment of animal charcoal; the manufacture of potash salts from the residues; Excise regulations, and Dr. Schiebler's calcimeter for the determination of the quantity of carbonate of lime in animal charcoal.

We commend this valuable work to all interested in the subject; and wish the author success in his endeavours to introduce and encourage the extensive cultivation of beet-root in this country, and thus place us on a level with our neighbours on the Continent who have so successfully carried it out.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his Correspondents. No notice is taken of anonymous communications.*]

Dr. Balfour Stewart's Opening Lecture at Owens College, Manchester

Dr. Balfour Stewart concludes his excellent Lecture lately delivered at Owens College, Manchester, and published in your number for Oct. 20th, with a broad classification of experimental and observational work into work requiring much time and work requiring comparatively little time for its execution. This appears to me a very useful suggestion. Dr. Stewart then goes on to say that the work requiring short periods of time "may be furthered with much advantage in institutions such as Owens College." And he adds that the same objects are at present aided by the Government grant of 1,000*l.* so carefully administered by the Royal Society; but he thinks this grant might be advantageously increased. In all this I quite agree with him.

Dr. Stewart then proceeds to deal with the other class of scientific work. And here I had better quote his own words. He says:—"But when we come to experiments and observations requiring great time, the case is very different. Certain experiments, whether from the great time they require, or the great expense they demand, cannot be well performed in a College; while routine and long-continued observations, such as those connected with the various branches of cosmical physics, are of such a nature as to require a central establishment to superintend their organisation and reduction. There is thus, I think, the necessity for a central establishment of some kind, devoted to that class of experiments and observations requiring great time, great space, and great expense for their completion."

In every word of this also I agree with Dr. Stewart. But I think a few words more are wanted to tell us by whom or how these institutions should be founded and supported. I, who have had the advantage of very frequently discussing the question with my friend Dr. Stewart, infer, without any hesitation, that he considers this should devolve on the State, which, as I have often stated in public, is my own opinion. But I think it a pity that, at a time when the question is attracting in scientific circles so much attention, this should have been left to inference by one so well qualified to speak with authority, and on an occasion which afforded so excellent an opportunity of educating public opinion, on a subject which, outside scientific circles, is so little understood.

Alex. Strange, Lt.-Col.

The Aurora Borealis

A pretty bright display of the aurora, which was witnessed here last evening, exhibited such peculiar phenomena, that although I am told that they are common accompaniments of the aurora here, a description of them may yet be new to some of your readers. The times given in the description are by estimation from the striking of town clocks; the night being dark, and the light of the aurora not sufficient to enable me to consult a watch.

At $8^h\ 25^m$ a straight double beam of faint white light extended from Altair in the west, across γ Andromedæ overhead, nearly to the E.N.E. horizon. The northern branch of the arch was the brightest, about 3° broad, and it was accompanied at a distance of 10° or 12° on the southern side by a parallel and fainter arch. I was prevented from watching the duration of this appearance and the further progress of the aurora until a few minutes after ten o'clock. At that time a few columnar streamers of white were visible in the west, one of which, very bright, extended from α Sagittæ to ζ Cygni, and was accompanied by fainter streamers from β to between γ and ϵ Cygni, and from Altair to δ Cygni. I noted their direction, and that of a few other streamers later, in opposite parts of the sky, in order to determine the position of their centre of convergence. But this was at the same time clearly shown by a patch of nebulous white light, 10° or 15° wide, from the centre of which, at β Andromedæ, and to some distance beyond its borders, faint rays spread outwards, and mixed themselves with faint streamers which rose in close array, from the north and east, towards them. While watching this small light-cloud, its light and that of the surrounding streamers became rapidly and brightly intermittent. It soon faded, and on reaching an eminence where I could command the whole northern sky from east to west, I found that all the features of the aurora were undergoing very rapid changes. Two of the many broad and bright streamers which rose in that direction at about $10^h\ 25^m$ were directed from β Ursæ minoris to γ Cephei, and from θ Aurigæ to Algol, having their bases at the former stars, and connected, apparently, by no regular fringe or arch below, but appearing at different heights between the zenith and the horizon, and occupying chiefly the north-west to north-east quarter of the sky. The full extent of the intermittent phase, of which I had before obtained only a confined and obstructed view, was now also visible. Waves of light coursed each other over the whole extent of the streamers in no very regular direction or succession, but so as to give the general impression that conflicting currents of air, chiefly from the north, blew out and carried along with them the light of the streamers towards their highest points, or from one streamer to another. Hardly more than a second was occupied by the waves in spreading from the horizon to the zenith; and in their number, appearing simultaneously, they appeared to vary from a quick succession of ripples to a single wave. This agitation of the streamers subsided at about $10^h\ 30^m$. The centre of convergence of the streamers between β and γ Andromedæ was variously marked at about this time by a faint corona, without enclosed light, or by a nebulous light-cloud composed of irregularly radiating beams. It was traversed, apparently, by the waves from the north, east, and west, as rapidly as other portions of the sky; and but little indications of the aurora were visible to the southward from this point. For

© 1870 Nature Publishing Group